AP® ENVIRONMENTAL SCIENCE
2014 SCORING GUIDELINES

Question 3

(a) Japan, Indonesia, and the Philippines are examples of volcanic island chains that have formed along subduction zones between plates in the western Pacific.

(i) Describe what happens when two tectonic plates collide along a subduction zone.
(1 point for a correct description of plate movement in a subduction zone)

- One plate is pushed beneath the other, or equivalent description
- A trench may be formed at the subduction zone

(ii) Explain how subduction leads to volcanic activity.
(2 points: 1 point for a correct explanation of one plate being pushed down and melted and 1 point for a correct explanation of molten material/magma rising to the surface near the zone)

(b) Although the landscape following a volcanic eruption may appear unable to support ecological communities, over time the area can be transformed through succession.

(i) What is primary succession?
(1 point for a correct description of the establishment of organisms where bare rock/ash/sand/inorganic substrate, or no soil previously existed)

(ii) Explain how primary succession can lead to soil formation on a newly formed volcanic landscape.
(2 points: 1 point for a correct explanation of the role of organisms in physically/chemically weathering rock and 1 point for a correct explanation of the role of organisms and decomposition in soil formation over time)

(c) In addition to volcanic activity, highly destructive tsunamis are generated along Pacific Plate subduction zones.

(i) Explain how a tsunami is generated along a subduction zone.
(2 points: 1 point for a correct explanation of tsunami generation resulting from an underwater earthquake and 1 point for a correct explanation of rapid water displacement leading to tsunami formation)

(ii) Describe one negative ecological impact that tsunamis have on coastal environments.
(1 point for a correct description of a negative ecological impact; only the first description given can earn points)

- Destruction of/loss of habitat such as mangrove forests, coral reefs, etc.
- Flooding resulting from tsunami waves can create saltwater intrusion into coastal ecosystems
- Drowning of terrestrial species

Question 3 (continued)

(d) Southern California experiences periodic devastating earthquakes along the San Andreas Fault, which is a transform boundary located along the eastern edge of the Pacific Plate.

(i) Describe what happens to the tectonic plates along a transform boundary at the moment when the earthquake occurs.
(1 point for a correct description of the movement of plates when an earthquake occurs)

- A large amount of energy is released
- Plates suddenly/rapidly slide past each other in opposite directions

(ii) Describe what happens to the tectonic plates along a transform boundary during the time between earthquakes.
(1 point for a correct description of tectonic plates along transform faults binding or locking-up causing pressure to build up over time)

ADDITIONAL PAGE FOR ANSWERING QUESTION 3

(a) i - When two tectonic plates collide along a subduction zone, the lighter of the two plates (the one with a lower mass) is pushed above/on top of the more dense plate, and the lighter plates are often those beneath land masses, while the more dense are usually the oceanic plates. The heavier plate, after having been submerged, is closer to the core now, and, due to higher temperatures, will melt into magma or mostly molten rock.

ii - The magma is now part of the cycle of magma that occurs beneath the cooler layers of the Earth, and if there is a hotspot near the zone/site of subduction, it has a pathway to the surface of the Earth, and hotspots are an indicator of a formulating volcano/ moderate volcanic activity

(b) i - Primary succession is the eventual transition of a. nondeveloped area of land, into one where there is a distinct balance of abiotic and biotic factors, and begins with the development of bedrock material into soil.

ii - Primary succession can lead to soil formation on a volcanic landscape because pioneer species such as algae, moss, and lichens will first

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began to form on the surface of the rock and from there will start to break down the soil. Soon the soil will be of good enough quality to accommodate primitive species, like grasses and weak plants, which contribute to the quality of the soil by going through several life cycles/generations - thus adding to the organic matter in the soil. Over time, more advanced species will overpower & replace the primitive ones, and the cycle will continue until the area reaches its "peak" stage.

(c) i- When the lower plate is subducted, the pressure leading up to the subduction is sometimes so great that the water above the subduction site (in an ocean) dips and rises again in one swift motion, resulting in an enormous wave - a tsunami - that will sometimes make its way toward land

ii- Tsunamis pose several impacts on coastal environments - one of which is that there is a likely chance of the wiping out of several animal populations. several may or may not survive, but due to this natural disaster, the biodiversity is greatly reduced, and it takes a lot of time for the animals/communities to bounce back

(d) i- At a transform boundary, the plates slide past each other. Sometimes this occurs very gradually, and sometimes very suddenly, after a buildup in pressure. When it is sudden, the release of pressure will often result

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in an earthquake

ii- This is the time when, if the transform fault is not occuring gradually, that there is a constant buildup of pressure, as the two plates are resisting the action of sliding past one another

ADDITIONAL PAGE FOR ANSWERING QUESTION 3

a)

i) when two tectonic plates collide at a subduction zone one plate is forced under the other. when the plate is forced down into the mantel it melts.

ii) The melting plate becomes magma which pushes upwards. when the magma finds a place to release through the crust a volcano is formed.

b)

i) Primary succession is the steps of growth for a landscape to go from being barren to being a mature ecosystem.

ii) When a volcano erupts the land around it becomes barren rocks. Slowly weathering breaks down the rocks and a thin layer of soil is formed. small plants can then grow. As these small plants grow and die more soil is created. with more soil larger plants can grow and biodiversity increases. This process repeats itself until even the largest trees can grow and there is a large range of life in what used to be a barren land.

ADDITIONAL PAGE FOR ANSWERING QUESTION 3

c)

i) Tsunamis are caused by underwater earthquakes along subduction zones. When the plates moves suddenly huge amounts of water are pushed upwards. This water becomes a giant wave. The wave moves across the ocean at a high rate of speed. When the wave hits shallower water as it aproaches land it gets even taller. When it hits land it breaks and water rushes inland causing massive amounts of destruction.

ii) Tsunamis dont only cause problems for the people along the coast, they also harm the ecosystems. The flooding of saltwater inland kills animals, plants, and destroys habitat.

d)

i) A transform fault is were two plates slide against eachother. When the plates get stuck and then suddenly brake free is when earthquakes happen.

ii) If the plates slide smoothly past eachother then they move so slowly that it has no effect on the people along the boundry. The only time the earthquake occurs is when the

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ADDITIONAL PAGE FOR ANSWERING QUESTION 3

Plates suddenly become unstuck.

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ADDITIONAL PAGE FOR ANSWERING QUESTION 3

a)i When two tectonic plates collide along a subduction zone, a lot of pressure is produced. The pressure pushes one of the plates under the other which raises the top plate. This process creates mountains as the plates are being pushed into each other.

ii. Subduction leads to volcanic activities because as the mountains form, molten lava from the earth's crust is pushed upwards leading to volcanic eruptions. Volcanic activities occur when the magma is pushed or forced through channels ~~into~~ inside the mountains to the surface.

b)i Primary succession is the beginning of organic activities in an area of land that has been previously destroyed by processes such as volcanic activities, clear cutting ~~and~~ or fire. It is a process where a primary specie helps to renew the land and make it habitable for other species of plants and animals.

ii. Primary succession can lead to formation of soil because when a pioneer species such as moss begin to grow in such areas, they break down the rock for nutrients. This continuous weathering of the rocks leads to soil formation and then other tolerant species begin to grow in the new soil. As they die, they decompose and add nutrients to the soil, making it conducive for more species of plants.

ADDITIONAL PAGE FOR ANSWERING QUESTION 3

b)i When an earthquake occurs along a transform fault, it means that two tectonic plates are sliding past each other in opposite direction at high pressure. At this point, the pressure has built up and the sliding causes the vibrations of the plates which is known as an earthquake.

ii. Between earthquakes along a transform fault boundary, pressure is usually being built up. At this point no earthquake occurs because the pressure is not high enough to cause vibrations of the plates. Once the pressure builds up, it must be released and this is when an earthquake occurs.

c)i. A tsunami is generated along a subduction zone when a land plate ~~sli~~ slides under an oceanic plate. The pressure pushes the water from the ocean unto the land and can be dangerous to plants, animals and humans.

ii. A negative ecological impact of ~~ts~~ tsunamis is that they result in mass destruction of habitat and species. It takes a long time for the habitats to recover and sometimes they never recover fully.

AP® ENVIRONMENTAL SCIENCE
2014 SCORING COMMENTARY

Question 3

Overview

This question was intended to determine students' understanding of volcano, tsunami, and earthquake formation as they relate to changes in ecosystems. The students were asked about plate activity in subduction zones, tsunami formation, soil formation through ecological succession, and the ecological impact of tsunamis.

Sample: 3A
Score: 10

Three points were earned in part (a): 1 point in (a)(i) for establishing that one plate moves on top of the other plate; 1 point in (a)(i) for the subducted plate being pushed down and melted; and 1 point in (a)(ii) for magma making its way to the surface. Three points were earned in part (b): 1 point in (b)(i) for establishing that biotic factors develop on bedrock in primary succession; 2 points in (b)(ii) for living organisms physically breaking down rock; and 1 point for the buildup of organic matter through decomposition. Three points were earned in part (c): 2 points in (c)(i) for establishing the underwater earthquake event and for displacement of water related to the earthquake and 1 point in (c)(ii)for "wiping out of several animal populations." One point was earned in part (d)(i) for a sudden movement/release of pressure during the earthquake event. An additional point could have been earned for establishing the buildup of pressure in between earthquake events, but the maximum of 10 points had already been reached.

Sample: 3B
Score: 8

Three points were earned in part (a): 1 point in part (a)(i) for a description of one plate being forced under the other and 2 points in (a)(ii) for the upward movement of magma, and the downward movement and subsequent melting of the plate. One point was earned in part (b): no points in (b)(i) due to a lack of clear description of the role of organisms acting on bare rock in primary succession and 1 point in (b)(ii) for description of decomposition leading to soil formation over time. Three points were earned in part (c): 2 points in (c)(i) for establishing the presence of an underwater earthquake in tsunami formation and for the displacement of water due to the underwater earthquake; and 1 point in (c)(ii) for loss of habitat due to saltwater intrusion. One point was earned in part (d)(i) for a description of sudden plate movement during an earthquake.

Sample: 3C
Score: 6

Two points were earned in part (a): 1 point in (a)(i) for describing one plate going under the other at the subduction zone and 1 point in (a)(ii) for describing upward movement of magma. No point was earned for the description of the melting of the plate. Two points were earned in part (b): no points were earned in (b)(i) due to a lack of clear description of the role of organisms acting on bare rock in primary succession; 1 point in (b)(ii) for a description of biological weathering; and 1 point for the biological contribution to soil formation over time. One point was earned in part (c): no point was earned in (c)(i) due to a failure to establish the tsunami as a single geological event, and connect the event to a rapid displacement of water; 1 point in (c)(ii) for the destruction of habitat. One point was earned in part (d): no point was earned in (d)(i) as the response failed to establish the sudden movement or release of energy during the earthquake; 1 point in (d)(ii) for demonstration of the buildup of pressure during the time interval between earthquakes.